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THE EFFECT OF THREE-DAY HYPODYNAMIA ON LIVER FUNCTION

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16. Abstract
The effect of three-day hypodynamia on liver function is studied. Seven subjects participated in a total of 16 tests, conducted with subjects sitting in chairs inclined at angles of 90° and 135°. The most extreme physiological arrangement, with respect to liver function, was with the chair back inclined at an angle of 105°.

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THE EFFECT OF THREE-DAY HYPODYNAMIA ON LIVER FUNCTION

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We conducted a study of the influence of three-day hypodynamia in a sitting position with various angles of inclination of the chair back (90°, 105°, 135°) on the function of a series of internal organs and systems of the organism, including the liver. Seven men who passed through examinations before and after the test at the clinic therapy faculty of the S. M. Kirov Military Medicine Academy participated in the experiment. In all 16 tests were conducted (6 each at chair back inclinations of 105° and 135° and 4 at 90°). During the day the subjects worked 10-12 hours and slept 6 hours. The remaining time was set aside for recreation; during this time, the experiments were conducted. The condition of protein metabolism, enzyme activity in the blood and bilirubin, fat, and carbohydrate hydrate metabolism were studied. Protein metabolism was evaluated via the blood protein fraction and the synthesis of basic procoagulants, fats by the content of cholesterol, total lipids, and beta-lipoproteins, carbohydrate metabolism by the blood sugar level while fasting and after glucose load, and enzyme activity of the liver by the content in the blood of glutamic-oxaloacetic transaminase (GOT) and glutamic-pyruvic transaminase (GPT). /65*

Under the influence of hypodynamia a small increase in blood protein content was noted, these changes, however, appearing to be below the limits of statistical significance. Above all, the total protein increased in the blood of subjects who sat in a chair at a 105° angle. Under these conditions the protein gain reached on an average 0.3%. In all subjects, particularly

*Numbers in the margin indicate pagination in the foreign text.

in those who sat in a chair at an angle of 90 and 135°, the content of the albumin faction in the blood somewhat increased. In those who sat in a chair with a back angle of 105° the quantity of albumin remained practically unchanged. The content of $alpha_1$-globulin also did not change. At the same the time the concentration of $alpha_2$-globulin in all markedly increased, except for those who sat in a chair with an inclination of 105° (at an angle of 135° the changes were statistically significant). The concentration of beta-globulin basically decreased, particularly at an angle of 135° ($P < 0.05$). The content of gamma-globulin remained practically unchanged. /66

On three-day hypodynamia a marked change in the synthesis of protein procoagulants which is accomplished, as is known, in the liver parenchyma, set in. Thus, the prothrombin requirement in all subjects was markedly lowered. This was manifested to the least degree at an angle of 105°. At an inclination of 90° the prothrombim complex decreased from 74 to 66.5 g% ($P < 0.01$). The rate of blood proconvertin synthesis was simultaneously lowered. There was a lesser decrease in those who sat in a chair at an angle of 105°. On the contrary, the concentration of total fibrinogen in the blood was raised. This gives a basis for considering that the acceleration of fibrinogen synthesis is a compensatory reaction for the lowering of blood coagulating ability.

It is possible to suppose as well that hypodynamia induces clear changes in the protein forming function of the liver. A functional shift apparently occurs in the parenchyma, which is expressed primarily in disturbance of the procoagulant synthesis process. Under the influence of hypodynamia certain changes in liver enzyme activity also arise. In particular the content of glutamic oxaloacetic transaminase in the blood decreases on the

average from 10.3 to 7.7 units. The decrease in concentration occurred in all subjects, independent of the conditions in which they underwent hypodyanmia. However, it is known that GOT is synthesized not only in the liver parenchyma but also in the heart muscle. Therefore, one must not entirely judge the condition of liver enzyme activity by the dynamics of this indicator under the conditions in question.

The concentration of glutamic pyruvic transaminase, which is only synthesized in liver cells, practically does not change. Thus, it is initially determined at an average of 7.7 units, and at 6.8 units after hypodynamia. However, a detailed analysis of the individual groups of subjects, divided according to the conditions of hypodynamia, allows one to note significant dynamics for this indicator as well. Thus, in those who underwent hypodynamia in a chair at angles of 135° and 90° the GPT content was markedly raised. In particular, this indicator increased on an average from 5.3 to 7.5 units (for $P < 0.05$); when the chair back was arranged at a 90° angle while at an angle of 105°, it decreased (from 9.3 to 7.3 units). The bilirubin excretion function of the liver does not markedly change. The data obtained allow one to consider that, in healthy people under the influence of hypodynamia in a sitting position at various angles of body inclination, a shift in liver enzyme activity is observed. It is generally acknowledged that an increase in the GPT content in the blood is an indicator of disturbance in liver cell function.

It was noted above that the condition of fat metabolism was judged by the cholesterol, total lipid, and beta-lipoprotein levels of concentration in the blood. The average concentration of cholesterol in the blood increased from 198 to 211.5 mg%. However, its dynamics were not statistically significant. Clearer changes

were manifested by the toal lipids. Their content in the blood increased from 636.1 to 851.2 mg%. The sharpest change was manifested in those who underwent hypodynamia at an angle of 135°. Thus, in the initial state the content of total lipids in their blood averaged 619 mg%; and after the experiment, 1070 mg% ($P < 0.05$). To a lesser degree lipid content increased in those sitting at an angle of 105° (from 595 to 709 mg%). The concentration of beta-lipoproteins in the blood practically did not change. Therefore, under the influence of three-day hypodynamia in essentially healthy people rather distinct changes in fat metabolism set in.

Blood sugar level on an empty stomach, on the average had a tendency to decrease. However, its variation was below the limits of statistical signficance. For a more detailed evaluation of the condition of carbohydrate metabolism, all subjects were given glucose loading before and after the tests. As a result of correlating the glycemic curves, it was noted that under the influence of hypodynamia, the hyperglycemic coefficient rose somewhat, on an average, and the postglycemic coefficient rose even more. The changes in the latter were statistically significant. Therefore, the glycemic curves were higher and more prolonged after the experiment. To a lesser degree these phenomena were observed in those who underwent hypodynamia at angles of 90° and 105°. Evidently, not only the hypodynamia itself, but also the position in which the subjects experience it influence the condition of carbohydrate metabolism.

As is already known, the level of hormonal activity of the adrenal cortex and sympato-adrenal system primarily influence the condition of the glycemic curve. For this reason, the elimination of catecholamines in the urine was studied. A clear

decrease in excretion of adrenalin and particularly noradrenalin was manifested. Therefore, one may judge from catecholamine excretion that three-day hypodynamia leads to a decrease in the activity of the sympatho-adrenal system.

In studying the dynamics of the content of 17-hydroxycorticosteroids in the blood and their elimination in the urine, it was also noted that under the influence of the factors in question in all subjects some decrease in the glucocorticoid activity of the adrenal cortex set in.

Thus, there was always a basis to expect that after the experiments the glycemic curve should be compressed, since the activity of the adrenal cortex and the sympatho-adrenal system was decreased in the subjects. However, we registered an increase in the hyperglycemic and postglycemic coefficients. In our opinion the indicated dynamics for the glycemic curve can be explained only as a lowering of glucose tolerance due to disturbance in the glyconeogenesis process in the liver parenchyma. In this condition, changes are most expressed in those who underwent three-day hypodynamia at an angle of 135°. The results of the experiments conducted show that three-day hypodynamia with the subject in sitting position on a chair causes changes in liver metabolic processes, primarily in the metabolism of enzymes, fats, and carbohydrates. The most extreme physiological arrangement of the human torso in these conditions is at an angle of chair back inclination of 105°.

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